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# NASA TECH BRIEF

*Marshall Space Flight Center*

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## A Range Expanding Signal Conditioner

### The problem:

Existing signal conditioners used with a telemetry system limit the resolution to approximately 20 millivolts for a 0- to 5-volt signal.

### The solution:

A range expanding signal conditioner improves the signal resolution by expanding the input in eight 0- to 5-volt ranges. It accomplishes this by a combination of zero suppression and amplification. In addition to the increased resolution, the circuit provides a high degree of common mode and noise rejection.

### How it's done:

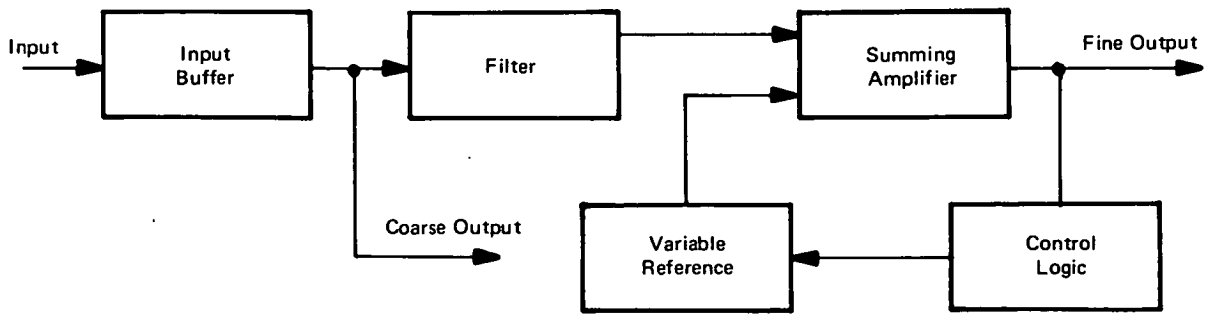
The zero suppression technique consists of subtracting a known voltage from the input and amplifying the remainder. The zero suppression is in eight 0.625 volt steps with an amplification factor of 7.6, giving an effective full scale output of 38 volts. The accuracy of the fine output is 0.3 percent of the input and that of the coarse output is 2 percent.

The figure is a simplified diagram of the circuit. The input stage accepts a differential input and yields a single-ended output. Two noninverting amplifiers in the input buffer provide a very high impedance to prevent loading of the signal source and to make the conditioner relatively independent of the source impedance.

The filter, which consists of an amplifier and its associated components, provides most of the filtering for both the ac common mode and the noise signals passed by the buffer. The filter has two poles to insure that noise will not cause oscillations in the control logic or significantly degrade the accuracy. The first pole has a break frequency of about 2 Hz, the second pole about 1.8 Hz. The overall attenuation of the network is greater than 100 for inputs of 20 Hz, and rolls off at 40 dB per decade. The filter is operated at a gain of less than one to compensate for the gain of the input buffer.

The summing amplifier receives a filtered and inverted replica of the input signal concurrently with one of seven discrete positive voltage levels generated in the variable reference. These are summed to provide zero suppression and are amplified to provide the scale expansion. The gain is set at 7.6 and the voltage from the variable reference is in 0.625-volt increments.

The variable reference is a digital to analog converter (DAC) whose output is varied by +0.625-volt, via the control logic whenever the output of the summing amplifier equals +4.95 or 0 volts, respectively. The control circuitry varies the output of the DAC to maintain a 0- to 5-volt output at the summing amplifier.




Range Expanding Signal Conditioner

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The input to the converter is reconstructed from the coarse and fine outputs in the following manner:

(a) The coarse output ($V_c$) and the fine output ($V_f$) are measured and recorded.

(b) $V_c$ is divided by 0.625 and the quotient is recorded.

(c) If $V_f$ is greater than 4 volts, 0.5 is subtracted from the quotient (b).

(d) The whole integer of result (c) is multiplied by 0.625 volt and the product is recorded.

(e) $V_f$ is divided by 7.6 and the quotient is recorded.

(f) The result of computations (d) and (e) are added to find the input voltage.

Step (c) is necessary to account for the hysteresis in $V_f$.

## Notes:

1. Information concerning this innovation may be of use in monitoring or in the expanded resolution of in-plant process functions.
2. No further documentation is available. Specific questions, however, may be directed to:
   Technology Utilization Officer
   Marshall Space Flight Center
   Code A&PS-TU
   Marshall Space Flight Center, Alabama 35812
   Reference: B72-10639

## Patent status:

Inquiries concerning rights for the commercial use of this invention should be addressed to:

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